

ETHOLOGY OF *PROCTACANTHELLA LEUCOPOGON* IN MEXICO
(DIPTERA: ASILIDAE)^{1,2}

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Abstract.—*Proctacanthella leucopogon* (Williston) occurred along the edges of an intermittent stream bed which passed through an overgrazed mesquite savannah near San Luis Potosi, Mexico. This species foraged from the ground or vegetation depending on the soil surface temperature. Prey were captured and immobilized in flight prior to landing to feed. While feeding, small prey were manipulated with all six tarsi as the asilid hovered above the feeding site; large prey were manipulated with a combination of tarsi at the feeding site. Prey consisted primarily of Diptera, Hemiptera, and Homoptera. Mating occurred in the male over female position. Females oviposited in the soil.

There are six described species of *Proctacanthella* in North America (Wilcox, 1965). Of these six species there is ethological information on only two. Detailed information is available for *P. cacopiloga* (Hine) (Dennis and Lavigne, 1975), and cursory observations have been made for *P. leucopogon* (Williston) (Rogers and Lavigne, 1972). The present paper adds to our knowledge of the ethology of *P. leucopogon*.

This species was studied near San Luis Potosi, Mexico, at an elevation of 1878 m above sea level. The general habitat was overgrazed mesquite savannah dominated by grasses in the genera *Bouteloua* and *Aristida*. *Proctacanthella leucopogon* was found primarily along the edges of an intermittent stream bed which served as a path, road, and bicycle trail through the habitat (Fig. 1). Along this path the vegetation consisted of sand burr (*Cenchrus* sp.), cat's claw (*Acacia* sp.), and mesquite (*Prosopis* sp.). Both *P.*

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Fig. 1. Intermittent stream bed habitat of *Proctacanthella leucopogon* near San Luis Potosi, Mexico. Fig. 2. *P. leucopogon* male with male of same species as prey.

leucopogon and *P. cacopiloga* have been reported to occur in sandy regions, cotton fields, other cultivated areas, and in *Buchloe-Bouteloua* grassland communities (Bromley, 1934, 1945; Dennis and Lavigne, 1975; James, 1938, 1941).

FORAGING AND FEEDING

On sunny days, *Proctacanthella leucopogon* was most active when the soil surface temperature varied between 29.5 and 45.5°C, which occurred between 9:00 AM to 12:00 PM and 4:00 to 6:00 PM. When the soil surface temperature was less than 29.5°C, *P. leucopogon* was very sluggish, flattened itself against the soil surface with its broadside to the sun and flew or "hopped" very short distances when disturbed by ants or an observer. As the soil surface began to heat up to about 33.5°C, this species remained in a similar position on the soil and began to actively make forage flights. Between this temperature and 37.5°C, *P. leucopogon* remained flattened, but faced into the sun. As the soil surface temperature increased to 41°C, specimens raised themselves from the surface and faced into or away from the sun. Once the soil temperature reached about 42°C, *P. leucopogon* moved onto sun exposed vegetation about 15 to 85 mm above the soil surface and foraged from there. However, when the soil surface temperature exceeded 45.5 to 47.5°C, *P. leucopogon* moved into the shade of vegetation and exhibited little foraging behavior. Even at these high temperatures, if the sun was obscured by clouds, specimens would return to the soil surface and assume a flattened position. Similar adjustments to diurnal variations in temperature have been observed for *P. cacopiloga* (Dennis and Lavigne, 1975) and several other species of Asilidae (Adamovic, 1963; Dennis and Lavigne, 1975; Lavigne and Holland, 1969).

While engaged in foraging from the soil surface, *P. leucopogon* rested with its body at a 45° angle to the substrate. One male was observed holding his fore tarsi crossed just above the surface, while in a foraging position (surface temperature about 42°C). A similar foraging posture has been exhibited by *P. cacopiloga* (Dennis and Lavigne, 1975) and for *P. exquisitus* Osten Sacken (unpublished). According to these investigators, such postures presumably reduce an asilids' body temperature by reducing the area of the body exposed to the sun's rays and heat reflected from the soil surface. Additionally, such a posture may provide asilids with a greater field of vision (Melin, 1923).

Proctacanthella leucopogon generally captured its prey in flight 5 to 10 cm above the ground and within 1 m of its foraging position. One male was observed to capture a leafhopper (Cicadellidae) just as it was landing on the soil surface. Dennis and Lavigne (1975) reported that *P. cacopiloga* captured its prey in the air at a height and distance similar to that which we observed for *P. leucopogon*.

Prey were captured in front of or to the side of this species foraging position. Once a prey was captured, *P. leucopogon* usually immediately inserted its hypopharynx in the dorsum of the prey's thorax or in the intersegmental membrane between the prey's head and thorax. Some prey were also immobilized prior to landing as the asilid hovered and manipulated the prey into position with all six tarsi and inserted its hypopharynx.

Proctacanthella leucopogon often captured prey and released them, while in flight, after briefly hovering and manipulating them with all six tarsi. The released prey were generally Coleoptera and it is assumed that the asilids were unable to insert their hypopharynx through the tough integument.

As *P. leucopogon* fed, the method used in manipulation of prey appeared to depend on the prey's size. Small prey, such as Cicadellidae, were generally manipulated with all six tarsi as the asilid hovered above its feeding site. Larger prey, such as instances of cannibalism, were manipulated with a combination of tarsi as the asilid rolled onto one of its sides. One male was also observed to manipulate an *Aceratagallia texana* Oman (Cicadellidae) with its fore tarsi while holding its position on the soil surface with its mid and hind tarsi.

At the completion of feeding, prey were either discarded at the feeding site as the asilid pushed the prey off its hypopharynx with its fore tarsi or the prey were merely allowed to fall off the hypopharynx. Some prey were also dropped in flight just before an asilid captured another prey. Rogers and Lavigne (1972) made similar observations for *P. leucopogon* in Wyoming.

The average time which *P. leucopogon* spent feeding on individual prey was 7 minutes 24 seconds, with a range between 4 and 11 minutes. However, one partial feeding of an unidentified Cicadellidae lasted 12 minutes 30 seconds. Larger prey, such as Cicadellidae and Miridae, were fed on for longer periods of time than were smaller prey such as some Diptera.

On two occasions, asilids dropped their prey in flight while foraging after another victim.

The following is a list of prey taken by *P. leucopogon*. The number and sex of the predator is indicated in parentheses following the prey record.

COLEOPTERA—Scarabaeidae: *Podolasia* sp., V-24-73 (♀); Scolytidae: near *Pityophthorus* sp., V-21-73 (♀). DIPTERA—Agromyzidae: *Phytolirio-myza* sp., V-23-73 (♂); Asilidae: *Proctacanthella leucopogon* (Williston), V-24-73 (♂); Bombyliidae: *Geron* sp., V-20-73 (♂); *Mythicomylia* sp., V-21-73 (♀,♂), V-22-73 (♀); Chloropidae: *Hippelates robertsoni* Sabrosky, V-20-73 (♂), V-21-73 (2♀), V-22-73 (♂); *Olcella parva* (Adams), V-24-73 (♀); *Siphonella neglecta* Beck, V-24-73 (♀,♂); Dolichopodidae: *Chrysotus* sp., V-21-73 (♀); *Medetera* sp., V-21-73 (♂); Ephydriidae: *Scatophila* sp., V-20-73 (♀), V-24-73 (♂); Lonchaeidae: *Dasiops* sp., V-20-73 (♂); Milichiidae: *Phleomyia* sp., V-23-73 (♂); Sarcophagidae: *Metopia argyrocephala* (Mei-

gen), V-23-73 (♂); Sphaeroceridae: *Leptocera (Rachispoda)* sp., V-20-73 (♂); Tachinidae: *Olenochaeta kansensis* Townsend, V-23-73 (♀). EMBIOP-TERA—Unidentified, V-21-73 (♂). HEMIPTERA—Cydnidae: *Rhytidoporus compactus* (Uhler), V-22-73 (♂); Lygaeidae: *Geocoris* sp., V-23-73 (♂); Miridae: *Spanogonicus albofasciatus* (Reuter), V-20-73 (♀, 2♂), V-21-73 (3♀, 1♂), V-22-73 (2♀, 1♂), V-23-73 (4♀, 4♂). HOMOPTERA—Cicadellidae: *Aceratagallia* sp., V-20-73 (♂), V-22-73 (♀); *Aceratagallia texana* Oman, V-20-73 (♀, 1♂), V-21-73 (5♀, 4♂), V-22-73 (2♀, 8♂), V-23-73 (7♂), V-24-73 (3♀, 3♂); *Deltocephalus sonor* Ball, V-20-73 (♂), V-21-73 (♀), V-22-73 (♀, 2♂), V-23-73 (♀), V-24-73 (3♂); *Exitianus exitiosus* (Uhler), V-21-73 (♂), V-23-73 (♀); *Polyamia* sp., prob. *tolteca* Kramer, V-22-73 (♀); *Stirellus obtutus* (Van Duzee), V-24-73 (♀, 1♂). HYMENOPTERA—Formicidae (all winged reproductives): *Acanthostichus* sp., V-23-73 (♂); *Conomyrma* sp., V-20-73 (♂), V-23-73 (♂); Halictidae: *Dialictus* sp., V-22-73 (♂). LEPIDOPTERA—Gelechiidae: *Faculta* sp., V-24-73 (♂); Olethreutidae: Unidentified, V-23-73 (♀). THYSANOPTERA—Phlaeothripidae: Unidentified, V-24-73 (♂).

Both sexes of *P. leucopogon* preyed most heavily on insects belonging to the orders Diptera, Hemiptera, and Homoptera (Table 1). These three orders comprised approximately 88.6 percent and 92.5 percent of the prey for males and females, respectively. Although males and females preyed primarily on insects in these orders, they fed on different species and often different genera. In Colorado Rogers and Lavigne (1972) observed *P. leucopogon* feeding on Diptera, Hemiptera, Homoptera, Hymenoptera, and Orthoptera.

This species was approximately 4.3 times as large as its prey (Table 2). Although females were slightly larger than males, they preyed on smaller prey. Thus, females had a larger mean predator to prey ratio than males.

Since we often observed male-to-male encounters, we postulate that *P. leucopogon* may set up temporary territories while foraging and actively defend them against other individuals of the same species. Specimens of this species appeared to set up territories by spacing themselves out, with one individual occurring every 2.5 to 5 m. According to Adamovic (1963), asilids restrict their hunting activity to a limited area and defend only the central part of this area. All other individuals of the same species either avoid or are driven out of an already occupied territory. Male *P. leucopogon* may have been forcing other males out of their territory when they grabbed and released or merely hit other males. Additionally, when males met in flight, they frequently circled each other in an upward flight to a height of 1 m above the ground. All of these agonistic behaviors may be the precursors of cannibalism, since the single instance of cannibalism observed was that of a male taking a male (Fig. 2).

Table 1. Number and percent composition of prey by insect order taken by *Proctacanthella leucopogon*.

ORDER	Male		Female		Total	
	Number	Percent	Number	Percent	Number	Percent
Coleoptera	0	0	2	5.0	2	2.0
Diptera	13	21.0	9	22.5	22	21.6
Embioptera	1	1.6	0	0	1	1.0
Hemiptera	10	16.1	10	25.0	20	19.6
Homoptera	32	51.6	18	45.0	50	49.0
Hymenoptera	4	6.5	0	0	4	4.0
Lepidoptera	1	1.6	1	2.5	2	2.0
Thysanoptera	1	1.6	0	0	1	1.0
TOTAL	62		40		102	

The predator occasionally becomes prey as when one male was fed upon by a female *Efferia* sp. (Diptera: Asilidae). Rogers and Lavigne (1972) reported *P. leucopogon* serving as prey of *Efferia staminea* (Williston). We also have observed a male *P. leucopogon* landing on a harvester ant mound and being immediately attacked by worker ants. After 15 seconds the male was completely immobilized and dragged into the ant nest.

COURTSHIP AND MATING

Only one complete mating was observed for *P. leucopogon*. This occurred at 9:43 AM when a female flew in front of a male. The male made a rapid flight forward and grasped the female on the dorsum of her thorax. The pair fell to the substrate and mating ensued in the male over female position. In this position, the male's abdomen passed around to the right of the female's abdomen and clasped her genitalia from below. The male's fore tarsi rested on the dorsum of the female's thorax and his hind and mid tarsi intermittently rested on the substrate or on the female's abdomen. The

Table 2. Relation between length of *Proctacanthella leucopogon* and that of its prey.

Sex	Predator Length (mm) ¹			Prey Length (mm)			No. of Prey Measured	Mean Ratio of Predator to Prey
	Minimum	Maximum	Mean	Minimum	Maximum	Mean		
Male	12.3	13.9	13.2	1.6	13.2	3.2	61	4.1
Female	13.1	15.2	13.6	1.5	7.0	2.9	40	4.7
TOTAL	12.3	15.2	13.4	1.5	13.2	3.1	101	4.3

¹ 10 predators of each sex were measured.

female's wings were spread at a 45° angle and passed over the male's mid femora and under his front femora; whereas, the male's wings were folded over his dorsum. A similar mating position is taken by *P. cacopiloga* (Dennis and Lavigne, 1975).

The mating occurred when the soil temperature on the surface was 38°C. The pair remained in-copulo for approximately 10 seconds before the male unclasped the female and both asilids flew off. *Proctacanthella cacopiloga* matings last an average of 45 seconds, with a range between 5 and 93 seconds (Dennis and Lavigne, 1975).

Although the mating was not preceded by courtship, males of *P. leucopogon* may exhibit courtship prior to mating, similar to that observed for *P. cacopiloga* (Dennis and Lavigne, 1975). Males were observed to walk along the ground with their fore legs extended out in front of them and to alternately wave the legs between their heads and the ground. This behavior usually took place when males were within approximately 0.5 m of another asilid. However, some males exhibited courtship behavior even though no other asilid was near them.

Female *P. leucopogon* were also observed to wave their fore legs as they walked along the ground. However, males were not observed near the females when they exhibited this behavior. In addition, females did not wave their fore tarsi as frequently or for as long a time as did the males.

OVIPOSITION

One complete oviposition was observed for *P. leucopogon*. This occurred at 4:05 PM when a female crawled on the soil into the shade of a small depression (2.5 cm long, 5 cm wide and deep) where the surface temperature was 38°C. The female probed the soil with her ovipositor as she crawled along the ground in her search for a suitable site for egg deposition. When she found a suitable site, she inserted her ovipositor and abdomen in the soil up to the base of her thorax. As she oviposited she bounced slightly in a rhythmic manner similar to the "tamping" action of *Proctacanthus micans* Schiner (Dennis and Lavigne, 1975; Rogers and Lavigne, 1972). At the completion of oviposition, the female briefly swept the soil with her ovipositor before flying off.

This oviposition lasted approximately 60 seconds during which the female deposited three creamy-white eggs (Fig. 3). The eggs measured 1.07 to 1.21 mm in length, and 0.38 to 0.48 mm in width. No sculpturing was observed on the egg chorions.

Numerous other females were observed probing for oviposition sites in the soil in the shade of vegetation, grass clumps, and under the toe of a shoe. These ovipositional patterns of probing behavior indicate that shade, as well as specific characteristics of the soil, are important factors in deter-



Fig. 3. Eggs of *Proctacanthella leucopogon* recovered from the soil where they were deposited.

mining where female *P. leucopogon* deposit their eggs. Female *P. cacopiloga* have been recorded ovipositing in the shade of vegetation or a cow pat (Dennis and Lavigne, 1975).

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